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SOME OBSERVATIONS ON THE FLORA OF THE NORTHWEST HIMALAYA

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During three years' service in an American college in the northern part of the Punjab I found time to spend two summers travelling in the northwest Himalaya and western Tibet. This part of the mountains is much drier than that further east in Nepal, Sikkim and Assam, where the mean rainfall is over 120 inches a year, and the flora is rich in types from western Asia while in the eastern Himalaya there is a large endemic and Chinese element that does not get much west of Simla. Although I travelled about 2,000 miles in the mountains, mostly on foot, I did not go west of Simla and most of my botanical observations are from the valleys of the Jhelam and Upper Indus.

Drude, following Brandis, classified the vegetation of the Himalayas altitudinally into four main regions: (1) an Alpine belt; (2) a temperate forest belt; (3) a subtropical forest belt; (4) a tropical forest belt. As one goes northwest the last two belts become narrower and narrower until at Rawalpindi, near the Afghan frontier, the tropical belt has disappeared and a narrow belt of low scrub is all that remains of the subtropical forest.

This gradual change is correlated with the decreasing effects of the monsoon, due largely to the distance from the sea. In the popular mind India is all a tropical country with palm trees, and tigers looking out of the jungles. In reality one sees practically no picture-book jungle and what is called jungle by the natives is an uncultivated bit which is covered with prickly scrub and

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1915]

251

valueless in every way. In fact one can go from Bombay clear up to the Afghan frontier and then down to Calcutta without seeing what he had expected to find on every hand. There is, of course, jungle in India but it is not the typical thing one sees from the car windows.

In the Punjab and Scinde, huge provinces in the northwest of India, the country is desert or semi-arid, and without irrigation most of the country would be uninhabited. In this region the flora is very similar to that of Arabia and Persia and this condition extends clear up to the tops of the first ridges of the Himalaya without being interrupted by tropical rain forests at the foot of the mountains as is the case toward Calcutta. Fine crops of wheat, sugar cane, millet, peas, mustard, etc., are grown in the Punjab, but they are dependent on the two short rainy seasons and on irrigation. The indigenous flora is surprisingly related to that of the great stretches of desert from northern Africa to Afghanistan. The tropical genera which require plenty of rain are not to be found. Only two or three ferns are reported from the Punjab and although there are 1,600 orchids reported from India scarcely half a dozen are to be found in the plains of the northwest.

The Indian side of the outer ranges of the Himalaya is largely clothed with this desert flora, but strangely enough, the northern side of the first important range is almost entirely different, being clothed with a warm temperate flora right up to the summit so that the tops of the evergreens could be seen plainly from where I lived in Rawalpindi twenty miles away. On the side away from India the forests are much like those in our Eastern States; on the Indian side, there is no true forest, but the trees and shrubs are small and are like those on the plains.

The names of a few of the Punjab types and of those on the other side of the range will show the contrast. On the south side acacias such as *Acacia arabica*, *catechu* and *modesta* are common. *Capparis aphylla*, *Tamarix gallica*, *Zizyphus jujuba*, *Melia Azederach*, *Albizzia Lebbek* and *Olea Europea* are among the commonest. On the other side, at Murree, a summer resort on the top and slopes of a mountain, overlooking the plain, I

found oaks, maples, poplars, holly, cherry, hawthorn, horse-chestnut and dozens of other genera that reminded me of home.

The cause of this great difference seems to be that the snow, which does not fall at all on the plains, lies much longer on the northern side of the mountains and keeps the ground damp enough for plants to get well started. On the Indian side it does not lie at all after ordinary storms, and there are scarcely any peaks with permanent snow. As a result the climate is much the same as that of the Punjab except for the gradually increasing effect of altitude.



FIG. 1. Even in July the sheltered valleys in Kashmir may have plenty of snow. On the slopes are found alpine plants in great variety. Amarnath, Kashmir.

Each summer we started for Kashmir by two-wheeled cart as soon as college closed in June. Kashmir proper is a wonderful valley about eighty miles long and from twenty to twenty-five miles wide. It is in the heart of the mountains and is nearly 200 miles from the plains by the Jhelam valley route. Politically Kashmir comprises several hundred thousand square miles of mountainous country including western Tibet, but most of the people, and most of the cultivation is in the valley itself.

The first twenty miles is nearly level and the plants I noticed

as commonest or most striking were the acacias, *Olea*, *Dodonaea*, *Nerium odorum*, *Cassia fistula*, *Melia*, and *Dalbergia*. As we ascended *Pinus longifolia* became commoner and the wild pomegranate, *Punica granatum*, began to be common and as we got up to about 4,500 the oaks, spruces and other Kashmir types were the important elements of the flora.

The pass over the outermost range which looks out over the plains is 6,000 feet, just 4,300 feet higher than where we started at Rawalpindi, but as mentioned before, the flora is as different as though it were another continent. But going down from the pass to Kohala, which is in the warm valley of the Jhelam, and is only 2,050 feet, such Punjab types as *Acacia arabica*, *modesta* and *albispina*, *Olea* *Melia* and *Dodonaea* reappear. They occur only in the valleys, however, and the hills are covered with forests of *Cedrus deodara* (which some take to be a variety of the cedar of Lebanon), *Pinus longifolia*, *Juglans regia*, *Prunus Padus*, *Pavia Indica*, *Picea*, *Abies*, *Acer*, *Quercus*, *Berberis* and the other types found near Murree.

The country between the first range and Kashmir is a rugged, well-wooded country with cultivation along the banks of the streams and on the terraced hillsides to which a small stream can be diverted for irrigation purposes. After a hundred and fifty miles of this type of country one comes out into the wonderful valley of Kashmir. It is about eighty miles long and twenty to twenty-five miles wide with a most wonderful circle of peaks that average 15,000 ft.

The valley itself is highly cultivated except for the large shallow lakes which are full of aquatic plants of great variety. The lotus, water lilies, *Euryale ferox*, *Traça natans*, potamogetons, sagittarias and a host more fill the water so that the horses and cattle wade out to browse on the water plants and the natives fill their boats and use the plants for fodder. Along the banks of the lakes *Iris*, *Euphrasia*, *Spiranthes*, *Menyanthes*, buttercups, polyganums and other new-world genera abound. All kinds of temperate fruits flourish on the hillsides; and pears, quinces, apricots, apples, peaches, plums, almonds, cherries, walnuts and mulberries are for sale in the bazaars and are canned or trans-

ported fresh to India if they can stand the rough journey by bullock cart. Curiously enough, the most characteristic trees of the valley, the Lombardy poplar and the chenar (*Platanus orientalis*) are not indigenous but are supposed to have been introduced in Mogul times. Rice is possibly the most valuable crop and the hillsides are terraced and irrigated with great care. Wheat, barley and maize are staple crops and all our common vegetables grow readily.

In Kashmir the tree line is close to 11,500 ft. and *Betula Bhojpatra*, a white birch, forms thickets at the upper limit. *Picea Webbiana* gets up to the extreme limit of forest, and below this are dense forests of *Cedrus Deodara*, *Abies Smithiana*, and *Pinus excelsa* mixed with *Taxus baccata*, *Pavia*, *Juniperus*, *Juglans*, *Celtis*, *Ulmus*, *Prunus*, *Fraxinus*, *Acer* and like temperate types.

A noticeable thing in this part of the Himalaya is the absence of a distinct band of rhododendron. Such a band, in many places so impenetrable that travel is impossible, is found clear along the outer Himalaya from China to the northwest of India. Oaks, too, are nowhere prominent as in the outer Himalaya.

Above the tree line and in the forest glades there are extensive Alpine meadows and there is a wealth of flowering plants that is remarked upon by every traveller. Very few of the genera are peculiar to Asia and almost all of them are related to our own or European types. Many species, even, as *Caltha palustris*, *Batrachium tricophyllum*, *Ranunculus sceleratus*, *Aquilegia vulgaris*, *Papaver dubium*, *Saponaria Vaccaria*, *Malva rotundifolia*, *Geranium Robertianum*, *Epilobium latifolium* and *Stellaria media* are found in both worlds.

After spending a couple of weeks in the valley of Kashmir, which is 5,000 feet or over, we moved on toward the "Great Range" of the Himalayas that separates the wooded, beautiful country that we have just been in from the arid Tibetan wastes on the other side. Beyond Kashmir there is no cart road, and all provisions and baggage have to be taken on the backs of ponies or coolies. The stages where tents can be pitched, or where there are government two-room rest houses, are about fifteen

miles apart and it is difficult to travel much farther in a day through so mountainous a country.

As we followed up the Scinde Valley from Kashmir, the mountains became grander and there was more snow in the sheltered valleys and on the mountain tops. Everywhere we found the principle applying, that the northern slopes, where the snow



FIG. 2. Old bridge over the Indus, Khalatze, Western Tibet. Even a desert like the surrounding country can be made to blossom when it is irrigated.

melted more slowly, were better wooded, until we passed the Zoji Pass. The Great Range of the Himalayas is so high that it stops the rain clouds which have passed the lower ranges and almost abruptly we get another change of flora just as we did when we left the plains of India. From a rich flora we passed in a day's march to that of an Alpine desert. There is a transition zone but it is hardly twenty-five miles wide. On the pass Thomson found only six Tibetan plants out of the 110 he enumerated while at Dras, the second stage beyond on the Tibetan side the figures are almost reversed.

Western Tibet or Ladak, while Tibetan in flora, customs, race and sympathy, is politically a part of the Kashmir state, so it is possible for Europeans to get permission to travel, while Tibet proper is still closed to the foreigner. It is a highly mountainous

country lying on both sides of the river Indus, and there is very little of a plateau about it. Tibet proper was for a long time supposed to be a vast plateau but it is also a series of mountain ridges with troughs between that have not as a rule been cut down by streams. There are some plains that are probably the beds of extinct lakes but none are very extensive.

The ranges in Ladak are, as a whole, from 17,000 to 19,000 ft. while peaks in all of them go higher. The rainfall is very slight, averaging between three and four inches a year. When there is any precipitation in the summer time, it comes as a slight blanket of snow and only a few drops fall in the valleys. It is so light that in some places the snow line is as high as 20,000 ft. As a result of this aridity cultivation is absolutely impossible without irrigation, and what little there is is found on the alluvial fans built up by lateral tributaries to the Indus and its main feeders. These fans are selected because it is possible to divert the water from the stream bed above the fan and by great toil and ingenuity lead it out on the tiny fields which are most carefully terraced. Sometimes the very soil is brought in baskets to make the little fields. Frequently the ditches are a mile in length and they are conspicuous landmarks because of the tiny band of green which grows up at the sides of the ditch. Desert plants will be found three feet from gentians.

A poor New England farmer would expect to starve on the amount of land a whole Ladaki village has for cultivation. Wheat, barley, buckwheat and legumes are the principal crops, and cultivation extends higher than in any other part of the world. There are villages up to 14,000 ft. and cereals will ripen at that altitude, although the growing season is very short. Above this live Tartar nomads that depend on their yaks, sheep and goats for their food.

Water is all the soil needs, for the finest potato tops I ever remember seeing were in the garden of a missionary doctor. He raised nearly all our common vegetables from German seed, although he lived 11,500 ft. above the sea. He had an experimental plot where he was testing the value of rye for introduction among the native farmers.

Even trees thrive when they can be watered and each village has a little grove of willows and poplars under government control for the benefit of the village. There are a number of other cultivated trees that do well in different parts of the country. These are the apple, walnut, mulberry and apricot, the last being the most important. In the apricot season the roofs of the houses are covered with the yellow fruit drying in the sun, and even the kernels are used for oil or food.



FIG. 3. On the hillsides scarcely a twentieth of the surface is covered with vegetation. The whole country is apparently above the tree line, but with irrigation even trees flourish. Near Dras, Western Tibet.

Indigenous trees are very few. *Myricaria elegans*, *M. germanica*, *Juniperus excelsa* and *Hippophæ rhamnoides* are the commonest. *Elæagnus*, *Betula Bhojpattra*, *Ulmus pumila*, *Lonicera glauca*, and *Fraxinus xanthoxyloides* are local. Four poplars are fairly common, *Populus balsamifera*, *P. alba*, *P. Euphratica* and the Lombardy poplar. There are no forests, and the only thickets are along the streams or on little islands in the streams. The conspicuous plants of these thickets are the two myricarias *Hippophæ rhamnoides* and *Clematis orientalis*, a fine creeper with dark orange brown or yellowish flowers. The most conspicuous plant of the rocky hillsides is a woody rose, *Rosa Webbiana*, with a wealth of pink flowers.

Continuous plant formations of any kind are very rare and are only to be found in the rare places where there is a spring, salt lake or stream. In the open desert scarcely a twentieth of the ground is covered with vegetation and only the toughest species have survived. These are perennials with much more below ground than above, and travellers frequently have to dig them out by the roots to get enough wood for a fire. Annuals are rare except where there is water.

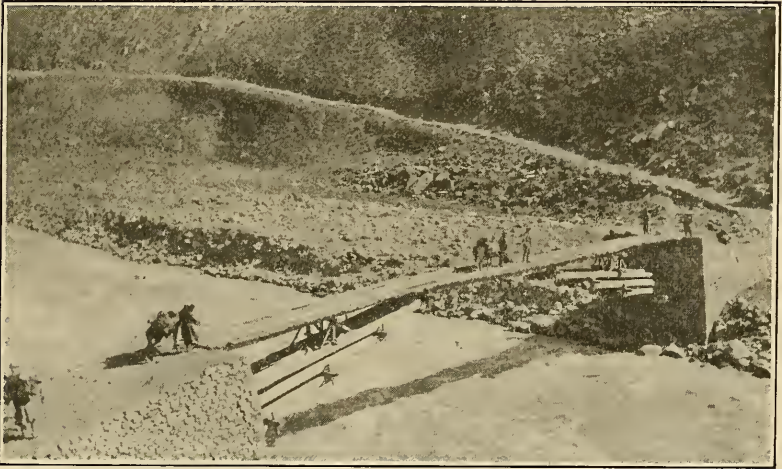


FIG. 4. There are practically no continuous plant formations in Western Tibet. Bridge over the Indus near Himis.

The flora of Ladak is richer than that of Tibet, but its affinities are with that country and Turkestan. It is not an old flora, for there are very few indigenous species, and the geologic history indicates that the present great elevation and the present desert flora is very recent. Composites, mints, peas and grasses are probably the commonest, and the following are some of the types that are most in evidence, *Ephedra*, *Echinops*, *Astragali*, *Capparis spinosa*, *Christolea crassifolia*, *Pedicularis tubiflora*, *Peganum Harmala*, *Eurotia*, *Caragana*, wild rhubarb and perennial potentillas.

Although the flora is not rich, it is a very interesting one, as it shows the ability of plants to adapt themselves to the most

difficult circumstances. Some types are found clear up to the snow line which is here close to 19,000 ft. and only perpetual snow is able to stop plant growth. One thing that puzzled me for a long time was the increase of the number of species toward the top of the mountains and passes, instead of a decrease with the increased altitude. This is of course due to the larger amount of rain and snowfall on the summits.

I have not completed my catalog of the species I found in this alpine desert country, but I do not think that it will include more than four hundred forms including the cosmopolitan weeds. In a single valley in Kashmir one can find more types, and so I cannot recommend western Tibet to the hunter for new species. It is a place where the struggle is not between plant and plant, but between the plant world and a hostile environment, and one can examine plant adaptations to some very definite climatic conditions.

NEW SPECIES OF GRASS RUSTS

BY J. C. ARTHUR AND F. D. FROMME

In attempting properly to account for all collections in hand while working upon the manuscript for the next rust number of the *North American Flora*, the following forms are found to be sufficiently distinct to be entitled to specific recognition. They are mostly recent discoveries, but such forms as *P. Leptochloae* and *P. unica* have had an uncertain disposition for a number of years.

Uromyces Jacksonii sp. nov.

II. Uredinia amphigenous and caulicolous, scattered, bullate, oblong or linear, 0.3–1 mm. long, tardily opening by slit in the epidermis, yellow; paraphyses none; urediniospores globoid, 21–26 by 24–30 μ ; wall pale yellow, moderately thin, 1.5–2 μ , finely echinulate, the pores 6–8, scattered.

III. Telia similar to the uredinia, long covered by the epidermis, blackish-brown; teliospores angularly globoid or ellipsoid, 19–25 by 20–30 μ ; wall light chestnut-brown, uniformly 1.5 μ thick, smooth; pedicel colorless, about half length of spore, delicate.